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Temporary Space and Business-matching Networks of the Semiconductor Industry in Kyushu, Japan

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Abstract

Japan's government has continuously supported Kyushu's semiconductor industry, which has thus been able to adapt to external environmental changes such as globalization and the rise of Asia's newly industrialized economies (NIEs). This study focuses on two promotional projects for the semiconductor industry carried out by the Kyushu Economic Research Center. The first is a support project for an international workshop on microelectronics assembly and packaging. The second is a business-matching project for semiconductor companies. This study conducted a social network analysis regarding the relational structure of temporary relations, and examined industrial upgrading in Kyushu's semiconductor industry. The results were as follows. First, the international workshop became an important event in global business for both domestic and foreign companies, and it strengthened existing personal networks. Second, the business-matching project helped to create mutual trust between firms with low mutual recognition and establish new transactional relationships with firms outside Kyushu.

Keywords: semiconductor industry, transactional relationship, temporary space, social network analysis

JEL Classification: L14, L63, R11

1. Introduction

After the “technopolis” plan was established by the Japanese Ministry of International Trade and Industry (METI) in 1980, Kyushu's semiconductor industry attracted attention from local governments as a “sunrise industry.” Since then, the Japanese government has continuously supported Kyushu's semiconductor industry with the goal of strategically fostering industries. Since 2001, the Industrial Cluster Program of METI has promoted the Kyushu Silicone Cluster Plan and supported the creation of semiconductor-related small- and medium-sized enterprises (SMEs) in Kyushu. Especially in Fukuoka Prefecture, a number of public institutions and research and development (R&D) centers related to the semiconductor industry were built under the governor's leadership. Moreover, the Knowledge Cluster Initiatives, launched by the Ministry of Education, Culture, Sports, Science and Technology (MEXT), have also supported Kyushu's semiconductor sectoral cluster since 2002 (Yokura et al., 2013).

Yamasaki (2003, p.319) noted that METI's Kyushu Silicone Cluster Plan has attracted attention for the following five reasons: (1) the agglomeration of semiconductor-related regional companies

in Kyushu; (2) the location of universities that can become joint research partners; (3) international conferences held in Kyushu; (4) the expansion of venture businesses from outside Kyushu and (5) the siting of the head office of Sony's semiconductor section.

Kyushu's semiconductor-related enterprises have played such a major role in silicon-chip production that Kyushu has been referred to as "Silicon Island." However, under the influence of environmental changes, such as globalization and the rise of Asia's newly industrialized economies (NIEs), Kyushu's semiconductor industry has shifted its focus from a volume-production facility to a technical R&D center. By constructing a network of various actors located in and out of Kyushu, the semiconductor industry has attempted to achieve an industrial upgrade.

This study focuses on two promotional projects for the semiconductor industry that were set up by the Kyushu Economic Research Center. The first is a support project for the international workshop on microelectronics assembly and packaging. The second is a business-matching project for semiconductor companies.

The temporary space, also called a "temporary cluster" (Maskell et al., 2004, 2006; Bathelt and Schuldt 2008, 2010), has been discussed as an important place where trust between participating actors is established through individual meetings such as international workshops (Yokura 2014). This study conducts a social network analysis regarding the relational structure of such temporary relations. Furthermore, interviews were conducted in June 2011 with the research staff of the Kyushu Economic Research Center—which has promoted international workshops and business-matching projects for Kyushu's semiconductor industry—to collect data regarding previous business-matching projects.

The remainder of this study proceeds as follows. Section 2 surveys the historical circumstances of the semiconductor industry in Kyushu (based on statistical materials). Section 3 examines the various functions of the international workshops in Kyushu. Section 4 explains the positive influence of the business-matching projects on business relationships and conducts a social network analysis for grasping the evolution of inter-firm networks. Section 5 concludes.

2. Semiconductor-related Industry in Kyushu

The development of semiconductor production in Kyushu has been subject to significant influence from the location of major electrical equipment manufacturers. For example, in 1967, Mitsubishi Electric built a factory that specialized in the preprocessing of semiconductor manufacturing in Kumamoto. Further, major semiconductor device makers, such as Kyushu NEC and Sony Kokubu, also began operations in Kyushu. The barrier to entry into the semiconductor-related industry was comparatively low when semiconductor production started in Kyushu. Therefore, new entrants from outside the semiconductor industry, such as local shipping companies and wholesalers, became semiconductor subcontracting companies who formed industrial agglomerations in Kyushu. When demand for integrated circuits dramatically increased from the mid-1970s, semiconductor production in Kyushu, which specialized in Dynamic Random Access Memory (DRAM), also grew rapidly. By 1985, 30% of the country's semiconductor production came from Kyushu.

However, due to the Japanese yen's appreciation after the 1985 Plaza Accord, overseas major semiconductor manufacturers transferred their labor-intensive processes overseas. Furthermore, low-cost international competition intensified as Asian nations fought one another over the production of semiconductors. As a result, the semiconductor industry of Kyushu transferred its DRAM manufacturing to Asian countries such as Taiwan, and began to specialize in the high value-added system of large-scale integrated (LSI) circuit manufacturing. Figure 1 indicates the

production value trend according to the integrated-circuit commodity in Kyushu from 1990 to 2010. Although the production value of MOS logic IC—used as the logic division of system LSI—was increasing at the time, the production value of MOS memory IC significantly decreased from 2000 onward.

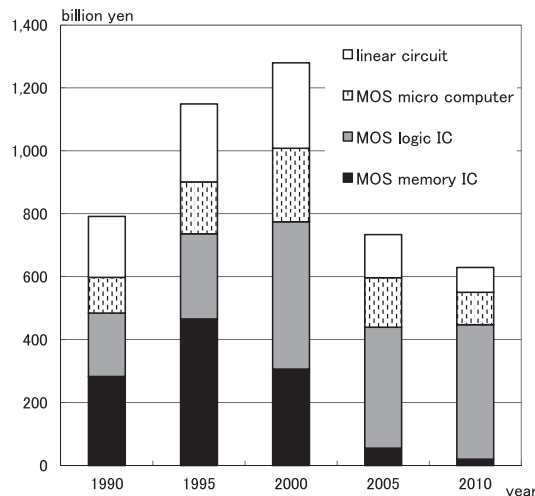


Figure 1. Trend in the production value according to integrated-circuit commodity in Kyushu

Source: Kyushu Bureau of Economic, Trade, and Industry Report

As Figure 2 indicates, there was a large number of employees in the prefectures where major semiconductor-related factories were located. Many electronics-parts- and component-related companies are located near the Tohoku Expressway, and the specialization coefficient of each prefecture in the Tohoku region is high. In Kyushu, the specialization coefficient is over three in Oita, Kumamoto, and Kagoshima Prefectures, and the number of employees is much larger than is the case with other prefectures.

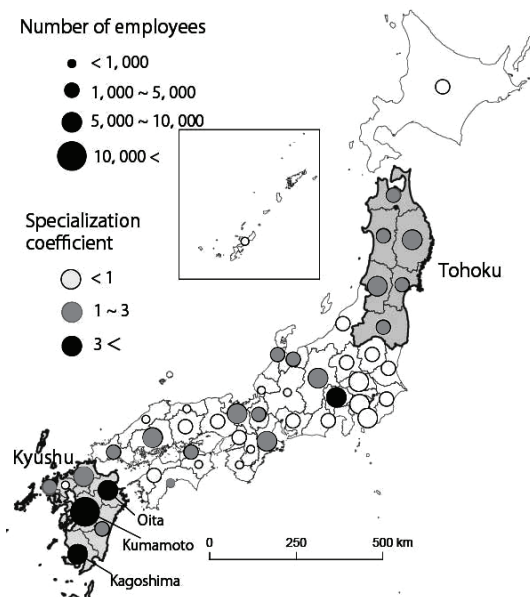


Figure 2. Distribution of semiconductor-related employees, 2010

Figure 3 presents the trend in exports to the primary countries and regions of the semiconductor-related industry in the Kyushu economic area. Exports to the U.S. and E.U. are comparatively small since Kyushu's semiconductor industry mainly targets the Asian market. Now, however, although exports to Association of Southeast Asian Nations (ASEAN) countries are decreasing, the presence of Korea and China in this market is still remarkable.

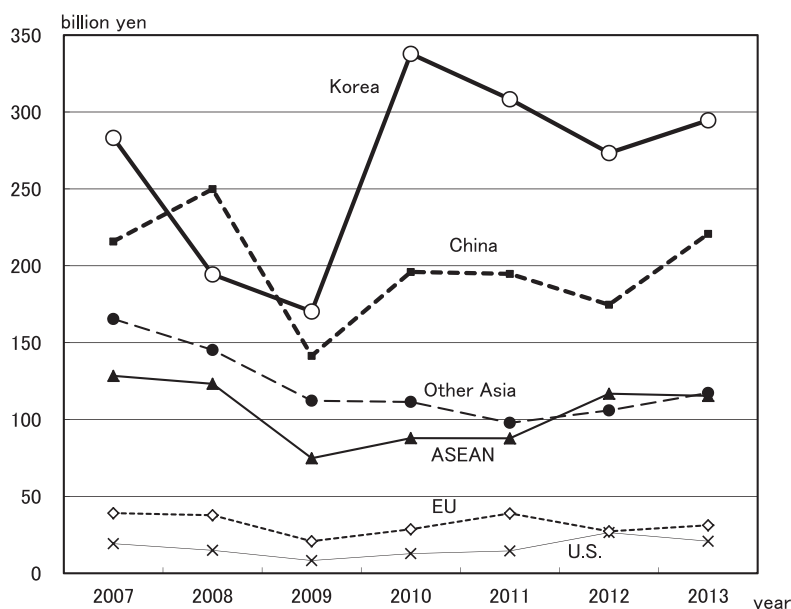


Figure 3. Trend in exports to primary countries and regions of the semiconductor-related industry in the Kyushu economic area

Source: Trade Statistics of Japan (Moji Customs)

The competitiveness of the semiconductor industry in Kyushu is in assembly and packaging technologies for high functional devices. In the miniaturization of mobile phones and personal digital assistants, the technology of mounting LSI chips in such modules is indispensable. Kyushu's semiconductor industry also has a competitive edge in having high-density packaging technologies such as System in Package (SiP) and 3D packaging. Several industrial support organizations and local governments in Kyushu are devoting significant amounts of energy to the formation of global business networks so as to upgrade the semiconductor-related industry.

3. Function of International Semiconductor-related Workshops

The semiconductor-related industry in Kyushu was supported with grants from the Japan Science and Technology Agency (JST) in the Joint-Research Project for Regional Intensive from 1997 to 2002. The project was useful for building relationships among semiconductor-related companies and researchers in Kyushu. Many SMEs in Kyushu called for an international workshop on semiconductor technologies to advertise such personal networks in Kyushu both at home and abroad. In 2001, the Kyushu Bureau of Economy, Trade and Industry and others hosted the first International Workshop on Microelectronics Assembling and Packaging (MAP) to help companies build business relations with foreign companies. The overall goal of MAP was as follows:

To facilitate the creation of a value network by linking Kyushu's over 700 IC affiliated companies with companies in Asia through open discussion and the sharing of state-of-the-art ideas, techniques, and perspectives on microelectronics assembling and packaging among leading industrial companies and academia. (Excerpt from the MAP brochure)

MAP provided participants with the opportunity to attend oral presentations or poster exhibitions in English. The majority of the participants comprised engineers who belonged to semiconductor-related companies, but there were also a few presentations from university researchers. As Figure 4 indicates, both the number of oral presentations and poster presentations increased in 2003 when host-buyer business meetings began. The number of poster presentations from China in 2003 and 2004 and from Korea in 2007 was significant. Furthermore, there were many presentations from India in 2010, the reason being that the executive committee of MAP specifically invited the buyers of this country to MAP in order to expand Kyushu's overseas market.

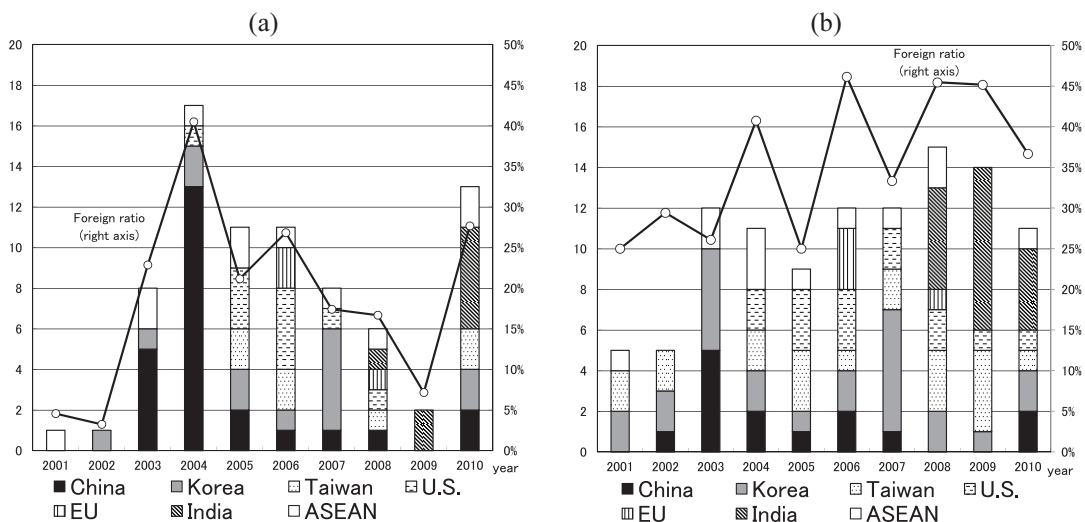


Figure 4. Trend in the number of oral presentations (a) and poster presentations (b) at MAP by country and region

The foreign ratio of oral presentations has reached between 25% and 45% (see Figure 4b). The number of participants from the U.S. and E.U. has also increased in recent years. Thus, the number of nationalities represented has also increased. The number of oral presentations from overseas reached a peak in 2008 with India having a prominent presence. This is because the Asia Semiconductor Trading Support Association (located in Kyushu) exchanged a memorandum of understanding (MOU) with the India Semiconductor Association in 2008.

As shown in Figure 5, there is a deep connection between the number of participants at MAP and the new-order ratio (defined as the number of new orders divided by the total number of business meetings), which indicates that MAP was effective. Furthermore, although the number of participants remained unchanged from 2001 to 2004, it rapidly increased from 2005 onward. The new-order ratio was large in both 2003 and 2004 (e.g., the number of new orders was 70 in 2003 and 182 in 2004), and this contributed to the rapid increase in the number of participants in 2005. However, the new-order ratio decreased sharply in 2007 (the number of new orders was only 29).

Thus, both the number of participants (domestic and overseas) in 2008 decreased. MAP's registration brochures provide the results of its previous economic performance, and participants can acquire information on the business opportunities provided by MAP. MAP's executive committee of MAP also provides participants with a list of semiconductor-related companies in Kyushu and East Asia. Therefore, MAP not only provides opportunities for semiconductor-related companies to present their research results but also helps build business relationships with other companies.

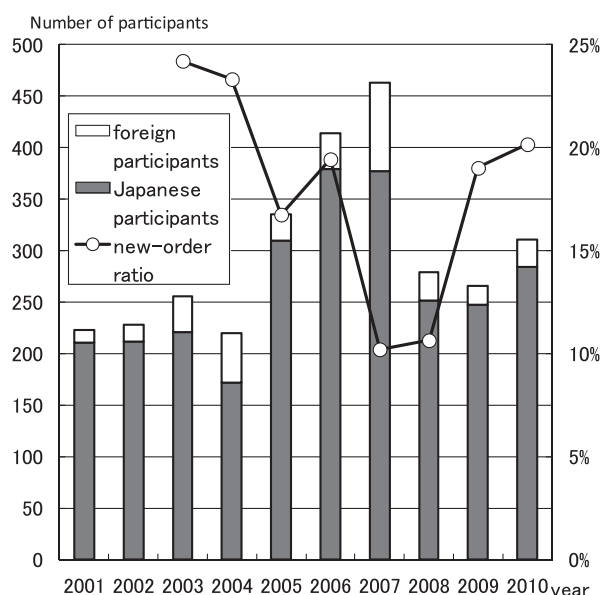


Figure 5. Trend in the number of participants at MAP and the new-order ratio

MAP also plays a very important role in reinforcing existing personal relationships. According to interviews with the research staff of the Kyushu Economic Research Center, it was important for participants at MAP to conduct an open exchange of opinions. Almost half the participants were “repeat participants” and semiconductor-related engineers, both of which helped strengthen personal networks at MAP. Furthermore, some engineers who participated in MAP set up semiconductor-related entrepreneurial ventures together. In this regard, MAP facilitated the mobility of human resources with specialized capabilities in Kyushu.

4. Business-matching Project for Kyushu's Semiconductor Industry

The Kyushu Semiconductor Industries & Electronics Technology Innovation Association (SIIQ) was founded for the purpose of promoting the semiconductor-related industry in Kyushu as an organization to operate the Industrial Cluster Program promoted by METI. SIIQ has promoted the business-matching project, referred to as “SIIQ DIRECT,” for semiconductor companies since July 2008. The Kyushu Economic Research Center was in charge of SIIQ DIRECT whose purpose it was to utilize the network of semiconductor-related companies in Kyushu and provide support to SMEs seeking new customers.

Furthermore, SIIQ DIRECT included a management function that introduced proper suppliers to customers in response to each customer's requests. The coordinators, who were highly knowledgeable in the semiconductor industry, played major roles in facilitating supplier–customer linkages. The majority of the customers were private enterprises as it was rare for colleges and public research institutes to become customers. For example, the number of customers who utilized SIIQ DIRECT totaled 247 in 2010, only 15 of which were customers from non-private enterprises. Moreover, SIIQ DIRECT was based on the personal networks developed by MAP so that semiconductor-related firms' technological capabilities were clarified.

The purpose during the early stages of SIIQ DIRECT was the formation of transactional relationships in Kyushu. It was assumed that both suppliers and customers were located in Kyushu. However, the person in charge of SIIQ DIRECT thought it important for the growth of the Kyushu semiconductor industry to consider building a network throughout East Asia on top of the network in Kyushu. This enabled firms in Kyushu and elsewhere to utilize SIIQ DIRECT.

The network drawing program, NetDraw, produced Figure 6, which illustrates the inter-firm network among customers and suppliers by SIIQ DIRECT from 2008 to 2010. The transactional relationships established are represented by the thick lines. Figure 6 also indicates the network flows of SIIQ DIRECT by drawing an arrow from the customers to the suppliers. The size of each node is proportional to the sum of the indegree and the outdegree, and the color of each node is based on the location (in or out of Kyushu). As Figure 6 shows, although it was a sparsely-connected network in 2008, specific nodes grew as a hub, mostly from relationships, and it became a dense network. That is, specific nodes were not only customers but also suppliers, and the network contained a large component that enabled them to link with other nodes in Kyushu or elsewhere. Furthermore, core nodes in the network had transactional relationships.

Table 1 demonstrates the descriptive statistics of the top six firms by degree centrality in 2010. Five firms, except for Firm F, were located in Kyushu, and they had been utilizing SIIQ DIRECT since 2008. Although all of the firms succeeded in having transactional relationships in 2010, the ratio of building business relationships by Firm B was comparatively low. Firm A was strong in semiconductor mounting technology and it received many orders in 2008 while also making an increasing number of orders to other firms in 2010. Conversely, although Firm B utilized SIIQ DIRECT as a customer in 2008, it received many orders as a supplier in 2010. Firms C, D, and E accepted orders as suppliers in 2008 and 2009, and they utilized SIIQ DIRECT as customers in 2010. Firm F had an advantage in technology connected to product evaluation and semiconductor substrate design, but it had been unable to accept orders from firms in Kyushu. Thus, their number of orders increased in 2010.

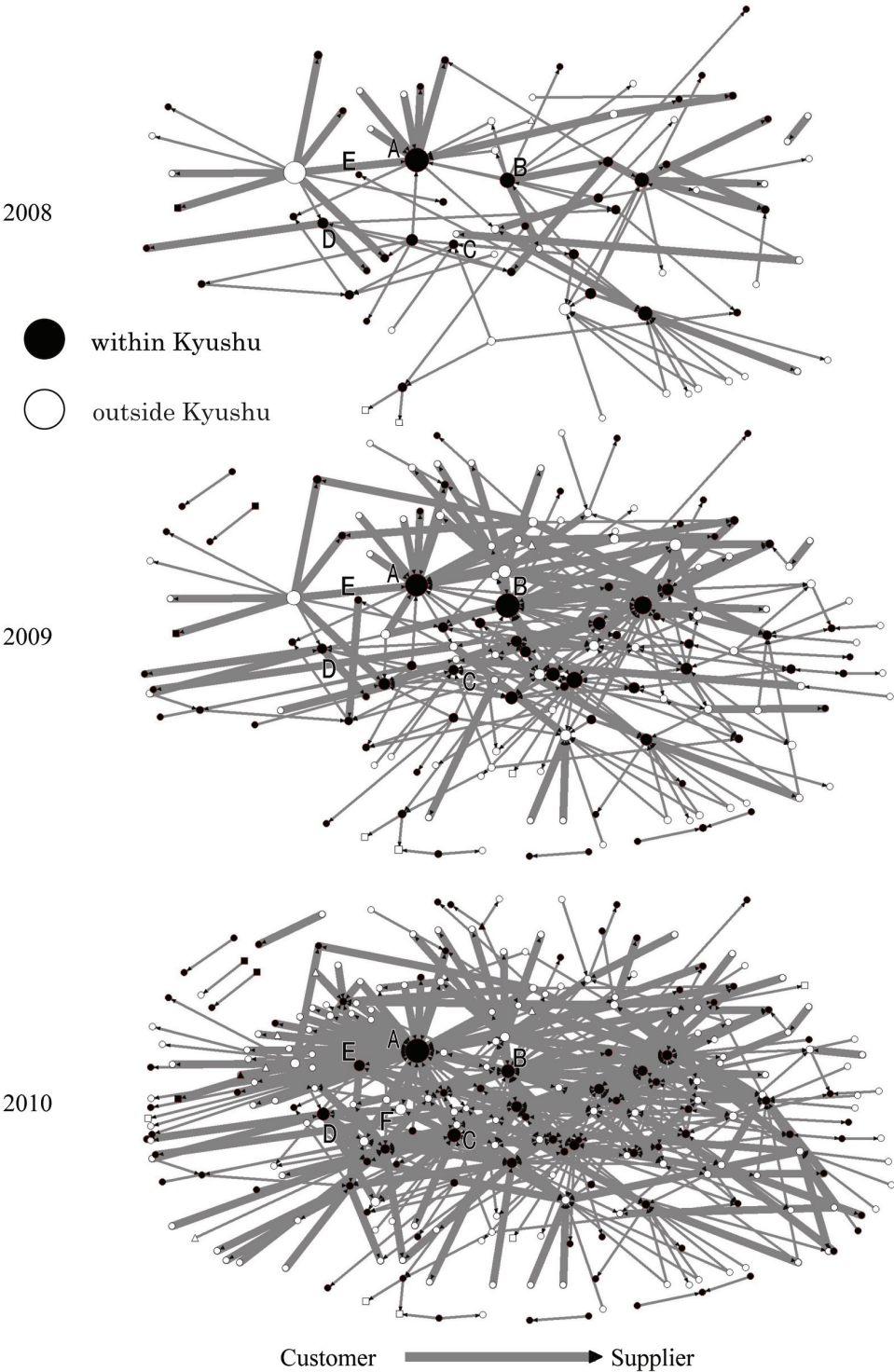
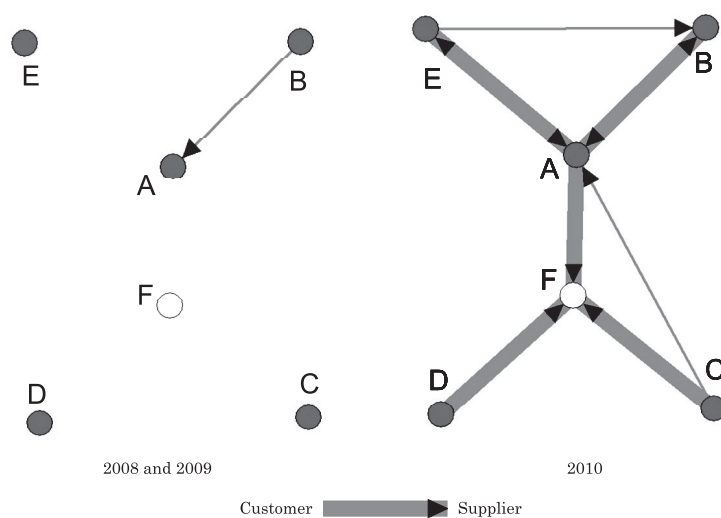


Figure 6. Customer-supplier networks in the SHIQ DIRECT project

Table 1. Top six firms by degree centrality

Firms	Year	Indegree	Outdegree	Degree centrality (a)	No. of transactional relationships (b)	Ratio(b/a)
A	2008	17	4	21	10	0.48
	2009	28	8	36	18	0.50
	2010	78	58	136	86	0.63
B	2008	2	9	11	2	0.18
	2009	17	22	39	6	0.15
	2010	25	33	58	14	0.24
C	2008	3	1	4	0	0.00
	2009	8	1	9	0	0.00
	2010	11	41	52	26	0.50
D	2008	2	2	4	2	0.50
	2009	4	3	7	3	0.43
	2010	4	34	38	34	0.89
E	2008	1	0	1	0	0.00
	2009	1	1	2	1	0.50
	2010	3	30	33	16	0.48
F	2008	0	0	0	0	–
	2009	0	0	0	0	–
	2010	33	0	33	26	0.79

Figure 7 presents the networks among the top six firms by degree centrality. In 2008, there was an inquiry regarding semiconductor device-related, trial-manufacture development from Firm B to Firm A, but no business partnership was established at that time. Although the relationships among the six firms did not change in 2009, there was greater diversity in the networks in 2010. The business relationship concerned with the semiconductor assembly and packaging between Firms A and B was established in 2010. There was a complementary relationship as both firms required advanced semiconductor technology. Moreover, they had continuously exchanged information regarding semiconductor packaging technology since 2008, and trust had now grown between them. This led to the creation of new transactional relationships in 2010. Although Firm E did not utilize SIIQ DIRECT until 2009, the relationship in semiconductor packaging between Firm A and Firm E was established in 2010. Furthermore, Firms A, C, and E were looking for advanced semiconductor assembly technology, and their relationships with Firm F, which had cutting-edge technology for semiconductors, were formed in 2010.

**Figure 7. Customer-supplier networks among the top six firms by degree centrality**

5. Conclusion

Japan's industry cluster policies by METI and MEXT have supported Kyushu's semiconductor industry by attempting to create a competitive advantage in system LSI and 3D semiconductor packaging technologies. Kyushu's semiconductor industry has since adapted to external environmental changes such as the reorganization of major firms and East Asian countries' technological "catching-up" with Japan.

The international workshop on semiconductor assembly and packaging has become an important global event for both domestic and foreign companies, and existing personal networks have strengthened. Furthermore, the business-matching project SIIQ DIRECT helped to create mutual trust between firms with low mutual recognition and to establish new transactional relationships with firms outside Kyushu. SIIQ DIRECT's structure of customer-supplier networks was sparsely-connected in 2008 and 2009 as it was extremely difficult for peripheral actors (which had small degree centrality) to exchange information. However, in 2010, the SIIQ DIRECT project employed knowledgeable coordinators in the semiconductor industry so that Kyushu's firms could find one another. These coordinators significantly facilitated the formation of dense networks in Kyushu's semiconductor industry.

Finally, it is important to enhance the support function of the business-matching project to advertise the advantages of Kyushu's semiconductor industry both at home and abroad. SIIQ DIRECT must develop its exploitation of overseas firms to maintain the competitive advantage that Kyushu has in semiconductor packaging technology. In this case, strong ties with an offshore company, which can help cultivate temporary space (such as MAP), will be helpful. Furthermore, when the specialized fields of the semiconductor technologies of various countries collaborate, they will help to affect the necessary industrial upgrades in Kyushu's semiconductor industry.

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